

age of Algeny
Agriculture and the artificial transmutation
of genes

by

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1. Mutations

The Dutch Scientist, Hugo de Vries, pointed out at the beginning of this century, that mutations or sudden heritable changes constitute the bricks of evolution. *hereditary determinants or* All genes in

living organisms mutate at different frequencies, thus providing the basis for the enormous diversity seen in the biological world. Most mutations *are* may be harmful but the odd beneficial ones preferentially survive under natural *and human* selection.

This is how man has evolved from microbes - through selection and *of genes* ~~gene~~ recombination *the late* acting upon blind mutations - a process which has been described by Prof. H.J. Muller as "muddling *one* through".

Mutations which may be harmful under *one* set of conditions may be beneficial in another environment. A good example of this is the frequent occurrence of the gene causing sickle cell anaemia in areas where malaria is endemic.

In such regions, persons with sickle cell gene are at an advantage, since they are not attacked by malaria, *while in other regions those having this gene suffer from a serious form anaemia*

2. Artificial induction of Mutations

Man acquired the ability to do what nature does for creating new variation, when Prof. H.J. Muller of the United States discovered in 1927 that mutations can be induced by X-rays.

This discovery earned him in 1946 the Nobel Prize in Physiology and Medicine. Since then, a wide range of radiations such as gamma rays produced by radio-isotopes and neutrons generated in *atomic* reactors have become available for treating

plants and animals. Also, a wide range of chemicals which produce mutations like radiations and hence known as "radionimetic chemicals" have been discovered. There is a growing understanding of how to manipulate the genes, without causing other associated undesirable effects.

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3. Mutations and crop improvement

The possibility for the controlled creation of variability has assumed great significance in agriculture. The variety is basic to all advances in food production. Unless there is the right type of plant, advantage cannot be taken of ^{sunlight,} water and fertilizer. There is enormous variability in nature in most crop plants and most of the high yielding crop varieties we cultivate ^{are the products of} result ~~from~~ an intelligent exploitation of natural variability. But even for this, some of the basic material is provided by naturally occurring mutations. For example, the genetic factors for dwarfing which are responsible for the high yield potential of the Mexican Wheats and ~~Taichung~~ ^{Taichung} rice arose as spontaneous mutations in the "Norin" Japanese Wheat and "Dee-gee-woon-geon" Chinese rice. Mutation breeding has hence become an invaluable supplement in the armoury of the plant breeder, particularly for rectifying any defects found in a good variety.

4. Mutations induced at the IARI

Several thousand mutations have been isolated ^{in recent years} at the ~~IARI~~ ^{Indian Agricultural} Research Institute ^{New Delhi} in wheat, rice, barley, potato, tomato, chilli, oilseed crops, cotton, jute and ornamental plants. ~~The following varieties from among~~ ^{named N.P. 836 and Sharbati Sonora} have been released for cultivation: ~~these two~~ ^{Through mutation}

(a) N.P. 836: ~~This~~ is a mutant variety having bristles or awns in the ears, produced by irradiating N.P. 797, a variety without bristles. N.P. 797 is popular in Bihar, eastern U.P. and West Bengal because of its high rust resistance. ^{Indian} farmers prefer the bearded wheats because of the bird problem. N.P. 836 was released for cultivation in 1960. Bristles have also been put into several other wheats such as Ridley, a popular variety in the lower hills.

(b) Sharbati Sonora: ^{is a dwarf wheat which was} ~~This variety was~~ ^{this year} recently approved for release by the Central Variety Release Committee of the Government

^{of India} ~~ICR~~ It is a mutant produced by gamma treatment of seeds of the Mexican ~~dwarf~~ ^{The} wheat, Sonora 64 ^{Mexican} strain has red grains, while the mutant has the ^{white,} sharbati grains which fetch the highest price in ~~the~~ ^{the} grain market.

Similarly, the commercial exploitation of hybrid vigour in Sorghum and Pearl millet became possible only after the discovery of male sterility, which occurred as spontaneous mutations.

Many other mutants in wheat, barley, toria and chilli are meaning the final stages of testing and are likely to be released in a year. *at the Indian Agr. Res. Institute*

5. Break through in the improvement of quality of food grains *Similarly, high yielding varieties of rice and groundnut have been developed at the Bhabha Atomic Research Centre, Bombay, through the induction of mutations*

The most urgent need of ^{India} our country is ^{the} improvement of the nutritional quality of ^{the} our food grains. There is widespread protein malnutrition in the country and it is ^{now} well established now that such malnutrition particularly in the young may cause a permanent impairment of mental and physical faculties. The prospects for meeting this ^{their} danger soon through increased production and consumption of animal products are not bright. Hence, proposals such as enrichment of wheat kernels with lysine are now being considered. Recent research at the IARI has shown that ^{the} protein quantity and quality ^{of proteins} can be improved greatly through induced mutations. Thus, Sharbati Sonora has 25% more protein than the parent Sonora 64. The japonica rice variety Taichung 65, which is giving high yields in the Mysore State, has sticky grains and a low amylose content. This has now been corrected by gamma ray treatment and a strain with the high yield of Taichung 65 as well as grains with a high amylose content and non-sticky nature has been developed. ~~This is undergoing trials in Mysore.~~ *Many high yielding varieties are being improved in this way for amylose content.*

It is hoped that soon a variety of Khesari dal which is free of the neurotoxin, β -N-oxalyl amino alanine which causes the disease lathyrism will become available. Similarly, attempts are in progress to reduce the content of leucine in jowar, which is responsible for the disease pellagra in Andhra Pradesh. ~~It is hoped that within the next two years~~ *of the Govt. of India* the high yielding varieties programme will become a high yielding-cum-high quality varieties programme.

6. New genes for tomorrow *Mutation breeding is creating many new genes for the future and developed*

a large variety of altogether new characters are being ~~created~~ *developed*. For example, wheat is being made to produce branching in the ear, like rice or ^{Sorghum} jowar. Different species are being created from a single species of wheat. The era of algeny (this is a term coined by Prof. J. Lederberg to indicate genetic alchemy or transmutation of genes) has thus truly begun. *There will*

Japonica in Sorghum strains with a high Vitamin A content have been identified

be immense possibilities for altering the architecture of ~~the~~ our cultivated plants in a direction which is favourable for the efficient use of sunlight and nutrients. What is more exciting is the opportunity that now exists for eliminating protein malnutrition through the genetic manipulation of quality in the food grains. Thus, the consumer will get much better quality of food at no extra cost. The era of alchemy, ~~or gene~~ a term used to denote genetic alchemy or the artificial transmutation of genes, has thus truly begun in India.